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# METHOD FOR THE SELECTIVE COATING OF CERAMIC SURFACE AREAS

The present invention relates to a method for treating the surface of a ceramic hybrid substrate having ceramic surface areas and metallic surface areas.

## Background Information

The use of ceramic (glass ceramic) hybrid substrates is known for example for the construction of electrical circuit arrangements. Such electrical circuit arrangements are used in various industrial areas, for example in the area of motor vehicle electronics for engine control, anti-lock braking control, or the like. The ceramic hybrid substrates contain processed electronic components and metallic conducting tracks, via which contacting of the hybrid substrates can occur. It is known that such ceramic hybrid substrates are obtainable by laminating individual function layers which may have electrical connecting leads, integrated circuit constituents, micromechanical structures or the like. Such a sandwich arrangement that includes several function layers is subsequently sintered so that the finished ceramic hybrid substrate is formed. The finished ceramic hybrid substrate therefore has a surface structure that includes some ceramic surface areas and some metallic surface areas (conducting tracks, pads) embedded in them. By miniaturizing such ceramic hybrid substrates, the distance between adjacent metallic areas can be in the range of < 100 $\mu$m. In order to be able subsequently to contact such metallic surface areas integrated in the so-called fine line technology, for example by bonding, the application of electrically conductive adhesives, or the like, it is known that the metallic surface areas can be finished, for example by applying a contact metal (silver, gold, or the like) to the metallic surface areas using a chemical deposition process. In this case, the ceramic hybrid

substrates are treated in chemical baths, some of which contain aggressive and etching substances which attack the surface of the ceramic surface areas. Moreover, it is disadvantageous that during the deposition of the contact metal in chemical baths, deposits of metals can also occur on the ceramic surface areas which can - in particular in view of the small distances between the metallic surface areas - result in short circuits. Moreover it is disadvantageous that during a subsequent contacting of the metallic surface areas, for example by an electrically conductive adhesive, the adhesive tends to flow (bleed), so that short circuits can likewise occur between adjacent metallic areas.

## Summary of the Invention

In contrast, the method according to the present invention having the features as recited in the preamble of Claim 1 and the ceramic hybrid substrate according to the present invention having the features as recited in the preamble of Claim 16 offer the advantage that a subsequent machining of the metallic surface areas or a subsequent contacting of the metallic surface areas may take place, with a reduced tendency to short circuits between adjacent metallic surface areas. By esterifying the ceramic surface areas of the ceramic hybrid substrate, it is advantageously achieved that the ceramic surface areas are protected selectively during the subsequent post-treatments in chemical baths. As a result of the esterification, a monomolecular surface layer is formed on the ceramic surface areas which is resistant to chemicals and heat, so that metal coatings chemically deposited in particular on the metallic surface areas are not able to deposit on the ceramic surface areas. Moreover, this selective esterifying of the ceramic surface areas causes a change in their surface tension, so that electrically conductive adhesives applied to the metallic surface areas do not tend to flow onto the ceramic surface areas.

The surface of the ceramic hybrid substrate is preferably treated with a solution having organic constituents tailored to the ceramic surface. This treatment preferably takes place via a dipping bath, flow wave soldering, spraying on, spreading on with a doctor, or the like. By wetting the surface with the solution having the organic constituents, the solution is deposited in micropores of the ceramic surface areas. Via a preferably provided subsequent heat treatment, crosslinking of the organic constituents of the solution with lattice structures on the ceramic surface areas takes place. This results in the formation of the chemically and thermally stable (resistant) surface coating of the ceramic surface areas. By a subsequent removal of non-crosslinked residues of the solution having the organic constituents preferably provided the solution is removed from the metallic surface areas, where no adhering effect (crosslinking) takes place. The metallic surface areas in the processed form and with the original properties are thus available for further processing.

A preferred use of the method according to the present invention is for ceramic hybrid substrates whose manufacture is silicon-based, in which the ceramic surface areas is treated with silicon as a solution containing an organic component (siloxane). The concentrations of organic silicon compounds are preferably between 0.1 and 1% of the solution - relative to the total volume. Using such a treatment, a silicon oxide or silicon dioxide surface layer that has good resistance to chemical and thermal influences may be achieved after the crosslinking of the solution with the ceramic surface areas.

Further preferred developments of the present invention appear from the other features recited in the subclaims.

Brief Description of the Drawing

The present invention is explained in more detail below with reference to exemplary embodiments illustrated in the related drawing.

Figures 1 through 3 show various phases of the treatment of the ceramic surface areas and

Figures 4 and 5 schematically show the esterification of the ceramic surface areas.

Detailed Description of the Exemplary Embodiments

In Figures 1 through 3, a ceramic hybrid substrate 10 (LTCC microhybrid substrate) is shown schematically. Ceramic hybrid substrate 10 has ceramic surface areas 14 and metallic surface areas 16 on its surface 12. Metallic surface areas 16 may, for example, be bonding pads, adhesive pads, or the like. The processing of such ceramic hybrid substrates 10 is generally known, so that further details of this will not be explained within the bounds of the present description.

The method according to the present invention for achieving a surface improvement of ceramic surface areas 14 is explained below.

First, as indicated in Figure 1, surface 12 is acted upon by a solution 18 having organic components. Solution 18 may act for example via a dipping bath, spraying on, flow wave soldering, or the like. This results in solution 18 being deposited on ceramic surface areas 14 and metallic surface areas 16. Excess quantities of solvent are removed mechanically, for example by wiping off, blowing off, centrifuging, or the like. This results in the formation of a thin layer of solution 18 on the entire surface 12, i.e., on ceramic surface areas 14 and metallic surface areas 16. Solution 18 adheres to surface 12 by surface tensions and penetrates surface pores.

Solution 18 includes for example a 0.1% siloxane solution.

Figure 4 shows a ceramic surface area 14 of ceramic hybrid substrate 10 in section. Ceramic hybrid substrate 10 is made for example of a silicon glass ceramic. Such silicon glass ceramics have reactive groups (OH groups). Wetting with solution 18, which in the specific exemplary embodiments contains silanes as organic components, is also shown in Figure 4.

Subsequently a heat treatment of ceramic hybrid substrate 10 takes place, for example at a temperature of about 100°C and for a period of about 30 minutes. This results in a silanization (etherification) of ceramic surface areas 14. The resulting crosslinking is shown in Figure 5. Silicon attaches itself to the reactive groups, forming an Si-O-Si structure. Such silicon structures, as is known, excel by their chemically and thermally stable properties. Free hydroxyl groups (OH groups) as reactive groups react with the silicon-containing educt, resulting in the formation of the Si-O-Si bond (siloxanes).

Then, as shown in Figure 2, residual quantities 18″ of solution 18 not crosslinked with ceramic surface areas 14 are removed.

This removal is preferably implemented by washing off with a solvent, for example isopropanol. This results in the surface coating of ceramic surface areas 14 with silicon components 18′ shown in Figure 3. Metallic surface areas 16 do not react with the organic components, so that they are unchanged after residual quantities 18″ have been detached chemically and mechanically.

Thermal decomposition of organic component $R_1$ may take place via a subsequent baking procedure, so that a silicon dioxide

layer is formed in ceramic surface areas 14, as indicated in the lower structural representation in Figure 5.

As a result of the method according to the present invention, ceramic hybrid substrate 10 has ceramic surface areas 14 that have a high chemical stability against etching attacks occurring in the subsequent manufacturing process. In particular, defective depositions on ceramic surface areas 14 situated between metallic surface areas 16 may be avoided with a subsequent deposition of metals, for example of silver, nickel, palladium, gold, or the like, on metallic surface areas 16. Thus the danger of short circuits is reduced. Moreover, the surface tension of ceramic surface areas 14 is changed such that electrically conductive adhesives applied to metallic surface areas 16 do not tend to flow, so that the formation of bridges or the like between adjacent metallic surface areas 16 is likewise considerably reduced.

The modification of ceramic surface areas 14 provided according to the present invention may be integrated into the total manufacturing process of the circuit arrangement having ceramic hybrid substrates 10, to produce various process advances. According to a first embodiment variant, silanization of ceramic surface areas 14 takes place after the manufacture of ceramic hybrid substrate 10 shown in Figures 1 to 3, i.e., before subsequent thick-film processes, baking processes, plating processes, provision of substrate 10 with conductive adhesives, bonding, or the like. In particular, a protective coating of ceramic surface areas 14 against chemical attacks in the chemical baths during plating (deposition of metals on metallic surface areas 16) is achieved here.

According to a further variant, the silanization of ceramic surface areas 14 may take place after the thick-film processes and baking processes. Silanization then takes place before

plating, conductive adhesive processes, or bonding. This results in the same advantages as in the first variant.

Finally, silanization of ceramic surface areas 14 may also take place after plating (metallization) of metallic surface areas 14. However, this does not provide a protective coating against the action of the chemical baths on ceramic surface areas 14. However, during a subsequent provision of substrates 10 with electrically conductive adhesives or bonding, for example, the flow of the adhesives is reduced by influencing the surface tension.

Depending on the desired processing, siloxanization of ceramic surface areas 14 may thus be incorporated at various points in time during processing.